Passive House Object Documentation

Single Family Home, Claverack, New York, USA
(Passive House database 1893)

2.1

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The Hudson Passive Project is a single family home, built for a client in Claverack, New York. The building is slab on grade with one main floor and a loft space containing two additional rooms above. Wall and roof construction is with structural insulated panels with expanded polystyrene cores. Orientation is due south.

Special features: Two-story glazed curtain wall oriented due south; roof windows to promote natural cooling.

U-value exterior wall:	0.115 W / (m^2K)	Effective heat recovery:	89.8%
U-value slab:	0.094 W / (m^2K)	PHPP Annual heating demand:	12 kWh / (m^2a)
U-value roof:	0.106 W / (m^2K)	PHPP primary energy demand:	109 kWh / (m^2a)
U-value window (avg.):	1.17 W / (m^2K)	Pressure test:	0.20 ACH50pa

2.2 Short description of the construction task

The Hudson Passive Project is a three-bedroom 145.6 m^2 detached dwelling which was conceived in 2009 as a home to be built for sale as the first certified Passive House in the State of New York. The site is located in the rural town of Claverack, New York, an approximately two-hour drive north of New York City. The style of the building evokes the local Shaker barn style of architecture, but with stone sidewalls similar to the stone field walls in the area.

Structural insulated panels (SIPs) were selected as the primary enclosure system in order to keep the construction simple with available labor and to gain experience for future projects. SIPs are locally available in the thicknesses and materials required. A SIP house could also be constructed quickly and with minimal thermal bridging. Large (up to 7.3 m x 2.4 m) SIP panels were used to reduce the number of joints. It was also thought (and proved correct) that SIPs would be a good choice for achieving superior pressure test results. Wall SIPs were 31.1 cm thick with a 28.9 cm thick EPS core, yielding an overall U value of 0.115 W/(m^2K). As seen below, thermal bridging at SIP panel joints was minimal, with single 28.9 cm thick lumber used in necessary locations such as at eaves and window headers. In other locations, joints were accomplished with no thermal bridging – for example at flat panel-to-panel joints, 1.5 cm thick OSB face splines were used. Roof SIPS were 31.1 cm thick with a 28.9 cm thick Neopor EPS core for an overall U value of 0.106 W/(m^2K).

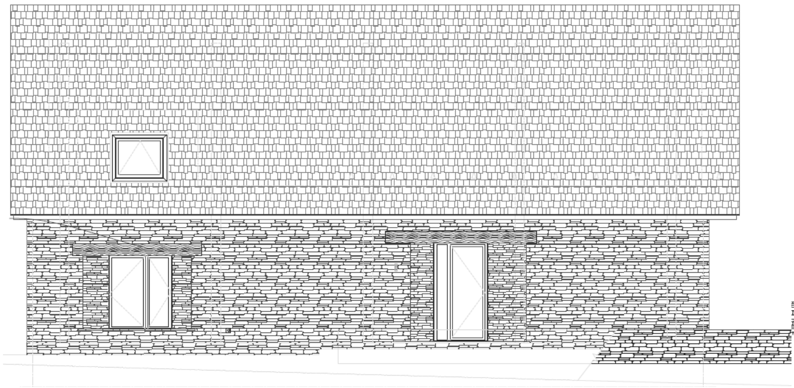
The house was built on a slab because the minimal heating equipment did not require a basement location. Under slab insulation is 30.5 cm thick XPS for an overall U-value of 0.094 W/(m^2K). Heating is accomplished with two mini-split heat pumps and one small resistance heater in the main bedroom for backup.

Windows are fiberglass frames with two panes of glass with a transparent suspended mylar film between, resulting in two air cavities. Roof windows are triple pane. Properties of the windows are provided in the following table:

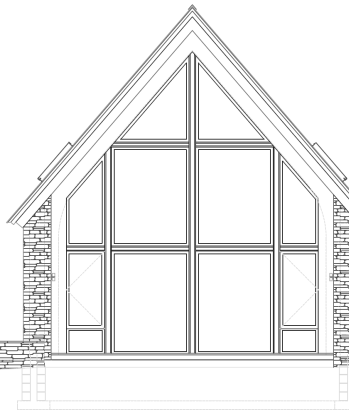
Window type	Frame material	Ug (W/m^2K)	Uf (W/m^2K)	g-value	Ψ_{Spacer} (W/mK)	Uw (W/m^2K)
Walls	Fiberglass	0.62 – 1.01	0.9 – 1.42	0.298 – 0.563	0.034	0.93 – 1.29
Roof	Timber	1.1	2.03	0.3	0.052	1.73

Construction commenced in May 2010 when the ground was broken and the site cleared. After the installation of the foundation and floor, the frame for the building was raised in June 2010. Wall and roof SIP installation continued through the following month. By September the envelope was complete with windows in place. Construction was essentially complete by the end of 2010 with interior finishing and landscaping. A timeline of the progress in pictures follows.

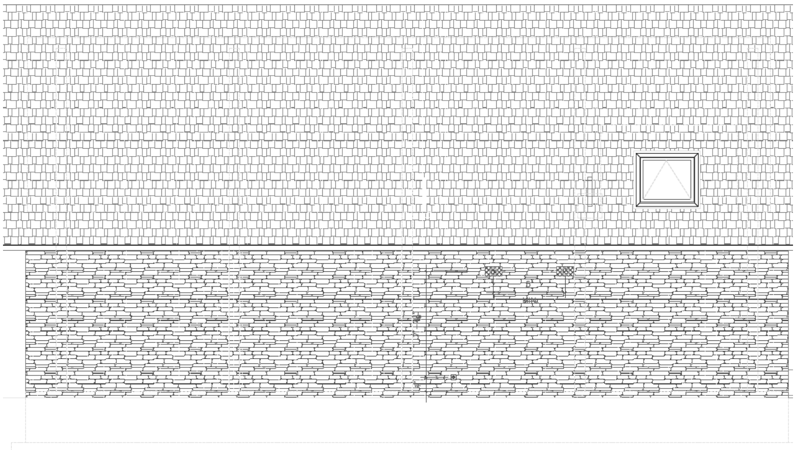
Elevations of the house are shown below.



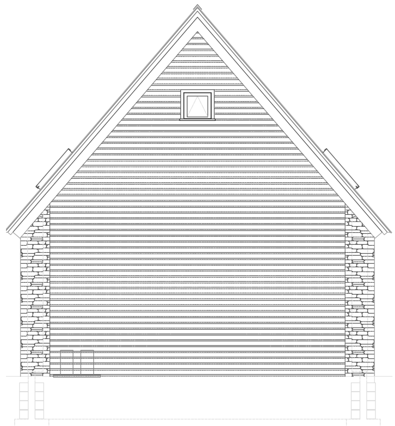
West elevation



South elevation



East elevation



North elevation

Figure 1 Elevation drawings

2.3 Exterior pictures of elevations of all accessible sides (at least 300 dpi, 7 cm x 10 cm)

Figure 2 West view


Figure 3 South view


Figure 4 East view


Figure 5 North view

2.4 Interior pictures

Figure 6 Interior view of first floor

Figure 7 Interior view of second floor

2.5 Cross section of the implementation plan

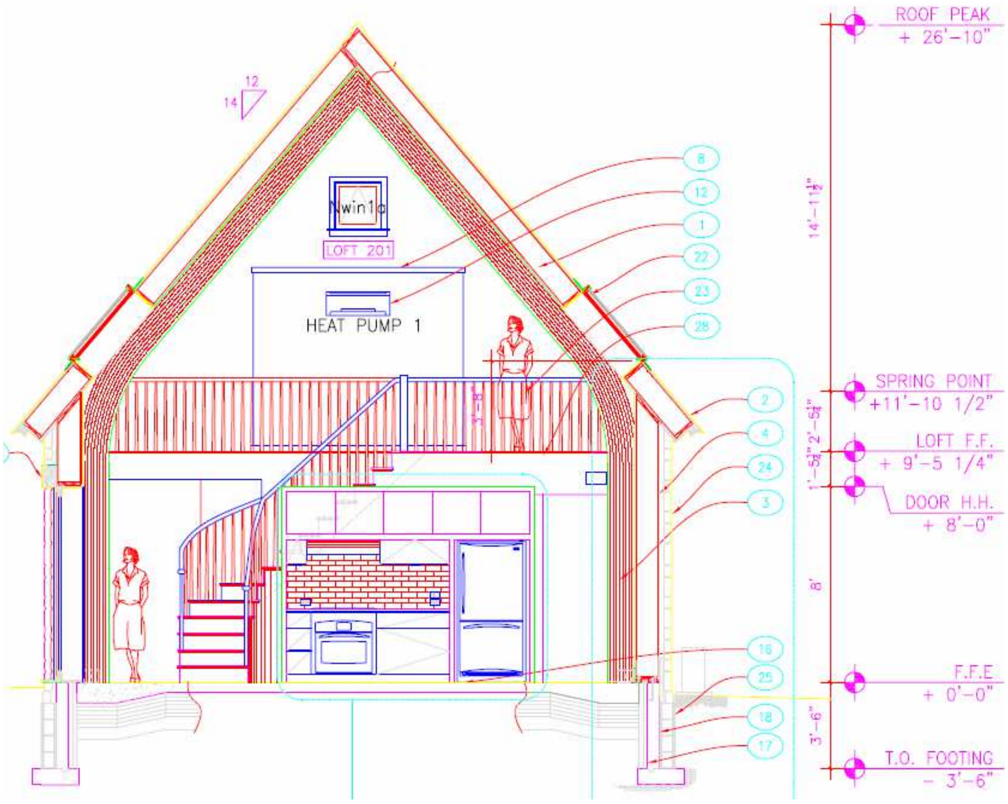


Figure 8 Cross section drawing

1 SIP roof panel
2 Asphalt roofing
3 Timber frame column
4 Drainage cavity behind stone claddir
8 Top of partition wall
12 Heat pump indoor unit
16 Polished concrete floor
17 XPS insulation
18 Poured concrete foundation wall
22 Roof window
23 Railing
24 Stone cladding
25 Concrete block foundation for stone cladding
28 Loft floor

2.6 Floor plans

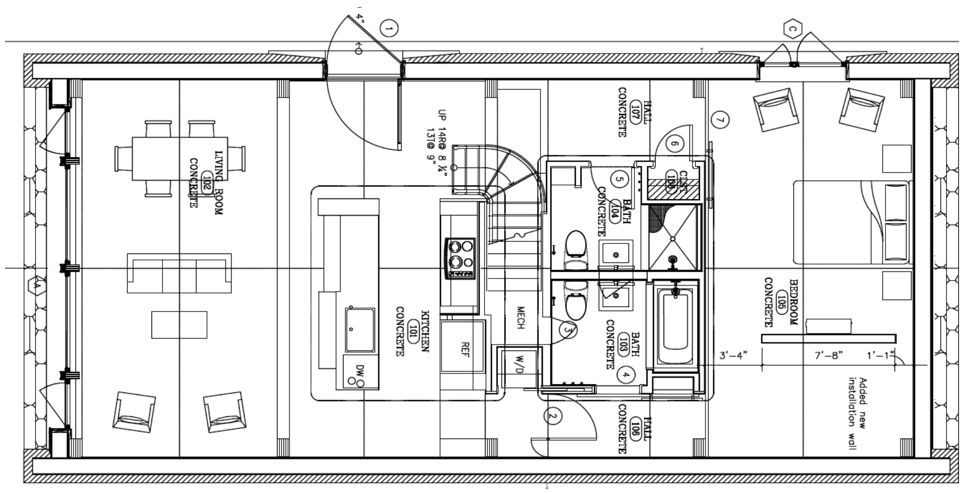


Figure 9 First floor plan

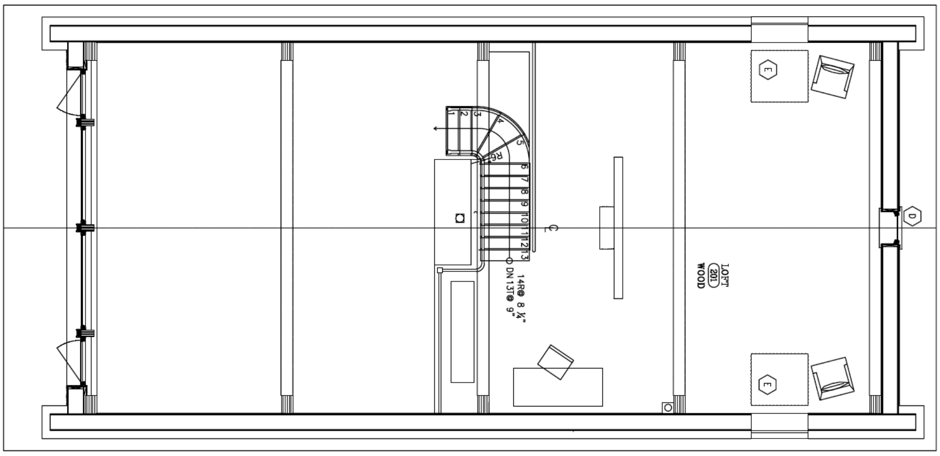


Figure 10 Second floor plan

2.7 Construction details of the Passive House envelope and building services

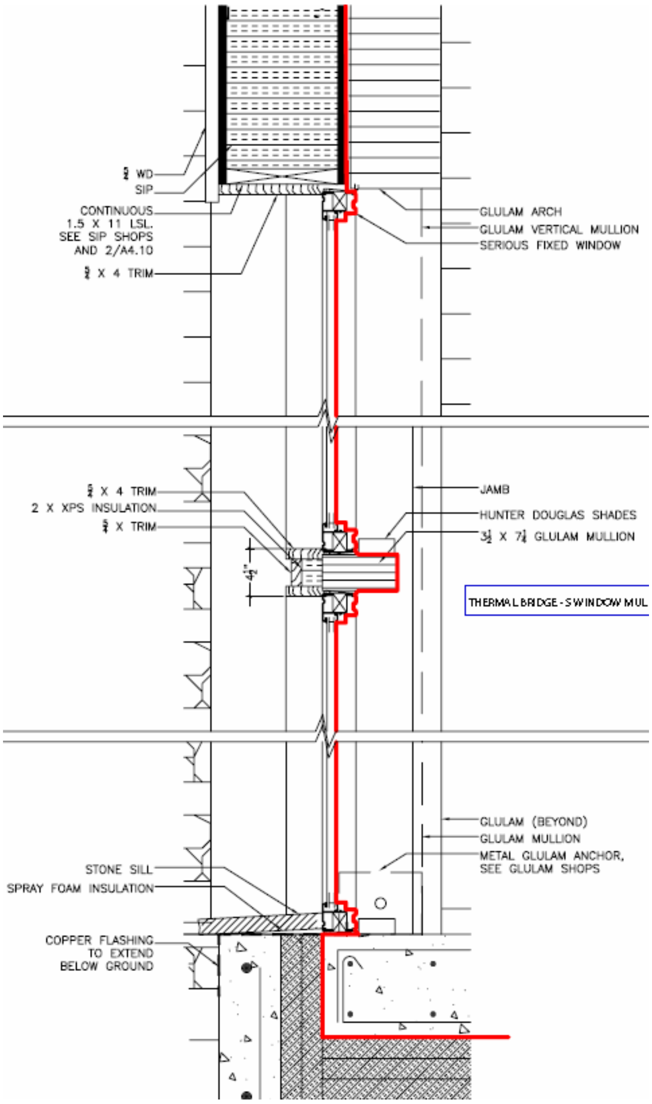


Figure 11 Vertical section through south curtain wall glazing including sill at slab, intermediate mullion and window head (red lines define air infiltration barrier)

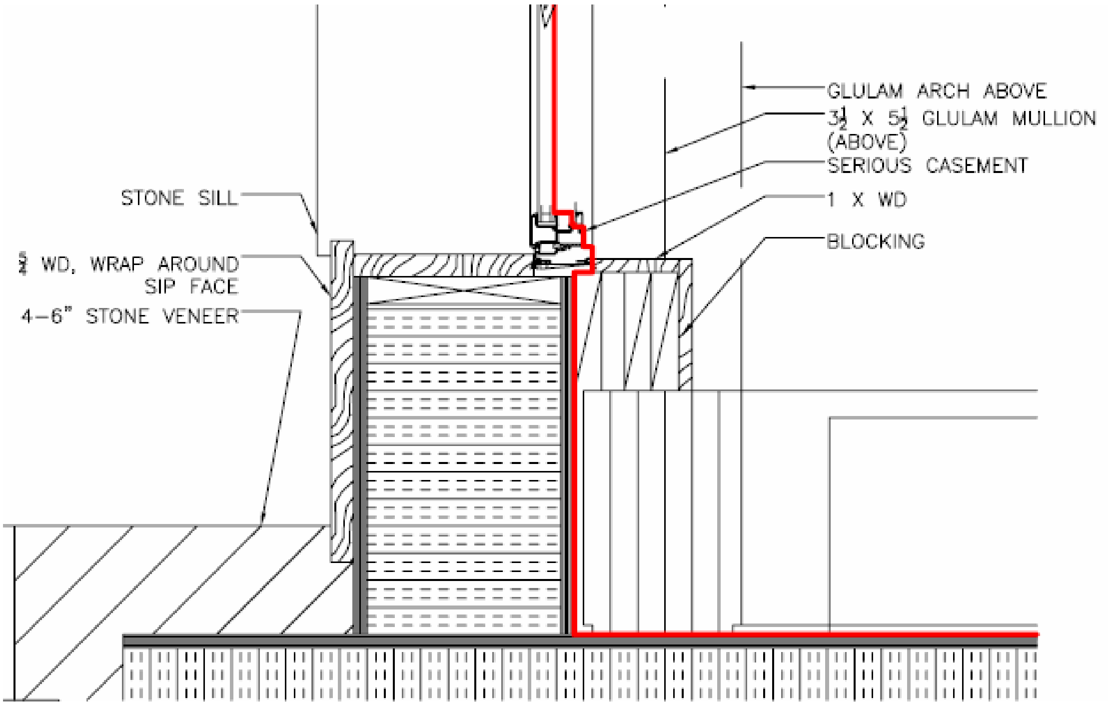
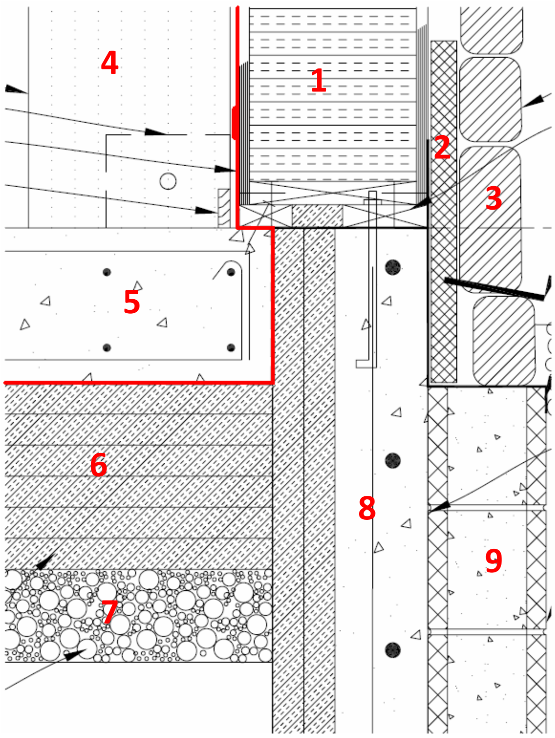


Figure 12 Horizontal section through south curtain wall glazing showing window jamb (red lines define air infiltration barrier)

2.8 Construction including insulation of the floor slab with exterior and interior wall connections



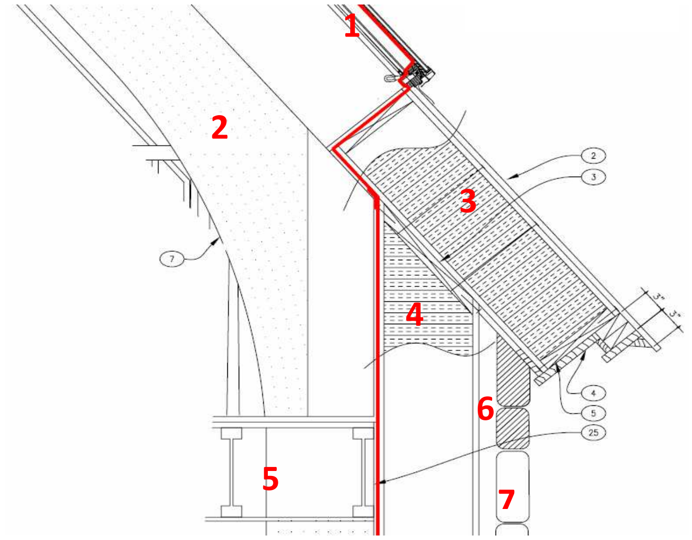
1. SIP wall panel
2. 5cm thick extruded polystyrene insulatic
3. Stone cladding
4. Timber frame
5. Floor slab
6. Under slab expanded polystyrene insulation (35.5cm)
7. Gravel bed
8. Poured concrete foundation wall
9. Concrete block bearing wall for stone cladding

Figure 13 Vertical section through slab edge at sidewall (red lines define air infiltration barrier)

2.9 Construction including insulation of the exterior walls with connections to other walls

There are no intersections between interior and exterior walls (see floor plans). Where timber frame columns abut exterior walls, SIP panels pass behind columns without interruption or thermal bridges.

2.10 Construction including insulation of the roof with exterior and interior wall connections

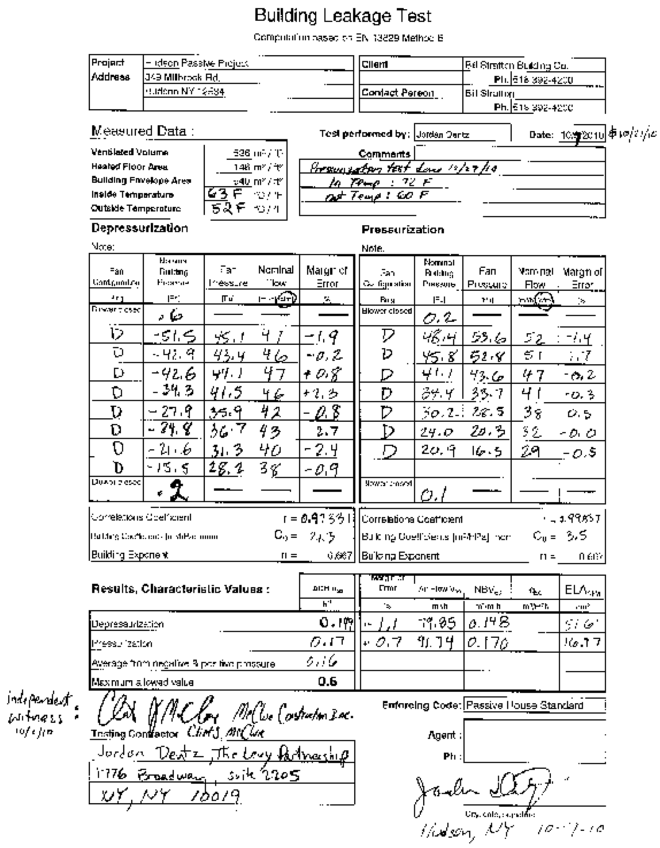


1. Roof window
2. Timber frame glulam arch
3. SIP roof panel
4. SIP wall panel
5. Second floor assembly
6. Drainage cavity (5cm)
7. Stone cladding

Figure 14 Vertical section through wall-roof connection (red lines define air infiltration barrier)

2.11 Description of the airtight envelope; documentation of the pressure test

Two pressurization tests were conducted – one at the rough stage and another after completion of the project. Final test results were certified at 0.20 air changes per hour at 50 pascals.



Building Leakage Test

Computation based on EN 13829 Method B

Project Address	Hudson Passive Project, 349 Millbrook Rd, Hudson NY 12534	Client	Bill Stratton Building Co., Ph. 518 392-4200
		Contact Person	Bill Stratton, Ph. 518 392-4200

Measured Data : Test performed by: Jordan Dentz Date: 10/?/2010

Ventilated Volume	536 m³
Heated Floor Area	148 m²
Building Envelope Area	540 m²
Inside Temperature	63 F
Outside Temperature	52 F

Comments: Pressurization test done 10/27/10. In Temp : 72 F. Out Temp : 60 F

Depressurization

Fan Configuration	Nominal Building Pressure (Pa)	Fan Pressure (Pa)	Nominal Flow	Margin of Error (%)
Blower closed	.6	—	—	—
D	-51.5	45.1	47	-1.9
D	-42.9	43.4	46	-0.2
D	-42.6	44.1	47	+0.8
D	-34.3	41.5	46	+2.3
D	-27.9	35.9	42	-0.8
D	-24.8	36.7	43	2.7
D	-21.6	31.3	40	-2.4
D	-15.5	28.2	38	-0.9
Blower closed	.2	—	—	—

Correlations Coefficient r = 0.97331; Building Coefficient C_0 = 2.5; Building Exponent n = 0.667

Pressurization

Fan Configuration	Nominal Building Pressure (Pa)	Fan Pressure (Pa)	Nominal Flow	Margin of Error (%)
Blower closed	0.2	—	—	—
D	48.4	53.6	52	-1.4
D	45.8	52.8	51	1.7
D	41.1	43.6	47	-0.2
D	34.4	33.7	41	-0.3
D	30.2	28.5	38	0.5
D	24.0	20.3	32	-0.0
D	20.9	16.5	29	-0.5
Blower closed	0.1	—	—	—

Correlations Coefficient r = 0.99857; Building Coefficient C_0 = 3.5; Building Exponent n = 0.607

Results, Characteristic Values :	ACH_{n50} (h⁻¹)	Margin of Error (%)	Air Flow (m³/h)	NBV_{50}	q_{50}	ELA (cm²)
Depressurization	0.149	-1.1	79.85	0.148		57.6
Pressurization	0.17	+0.7	91.74	0.170		16.77
Average from negative & positive pressure	0.16					
Maximum allowed value	0.6					

independent witness: Clint J McClure, McClure Construction Inc. 10/?/10

Testing Contractor: Jordan Dentz, The Levy Partnership, 1776 Broadway, suite 2205, NY, NY 10019

Enforcing Code: Passive House Standard

Agent :
Ph :

City, date, signature: Hudson, NY 10-?-10

Figure 15 Pressurization test report

A three-part strategy was used to achieve airtightness. First, caulk and adhesives were used to join SIP panels and between SIP panels and elements such as windows and the foundation. Second, two-part spray foam was applied in gaps between panels, around windows and to seal electrical penetrations. Finally, a SIP flashing tape (cured butyl-based adhesive with cross-laminated polyethylene membrane) was applied to all SIP seams, fastener penetrations and other joints.

Figure 16 SIP flashing tape

Figure 17 Spray foam at plumbing penetrations

2.12 Ventilation plan for the duct work (example)

The ductwork layout is shown in the figure below. There are two supply outlets: one supply duct runs from the HRV to the main living space and a second supply branch splits off and runs to the bedrooms on the second floor. There are three return inlets: one in each bathroom and a third in the stair near the kitchen. The largely open plan and high ceilings promote mixing of air throughout the home.

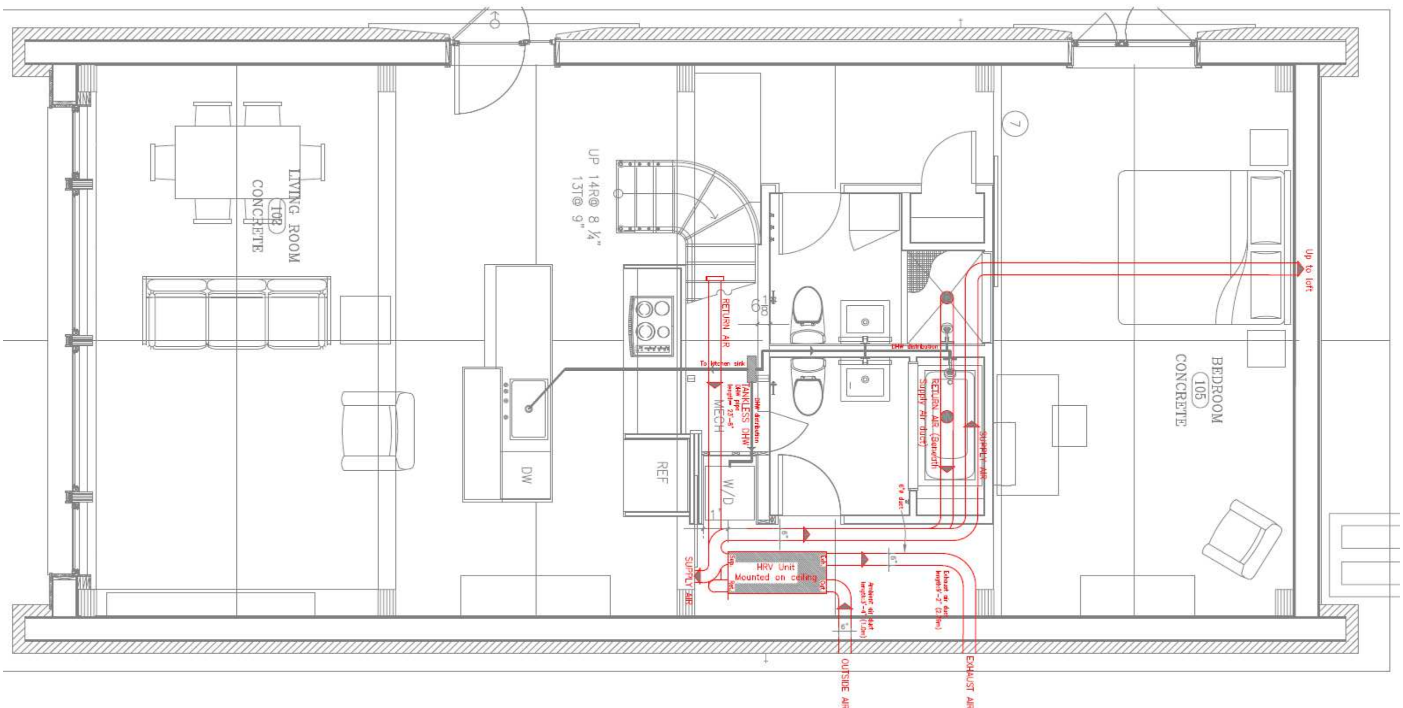


Figure 18 Ventilation duct plan – full floor plan

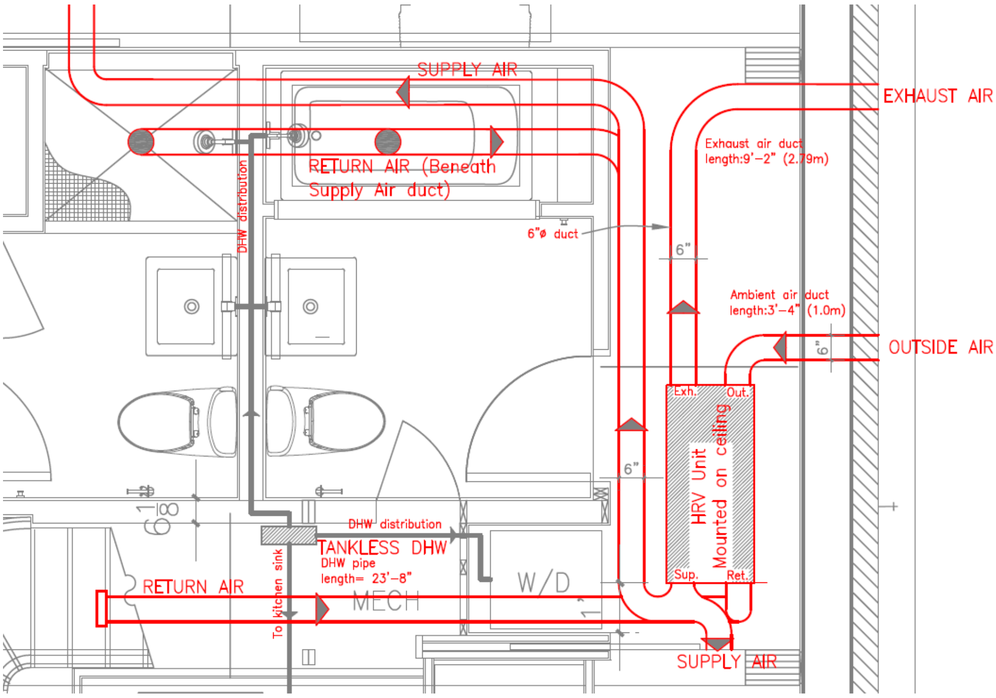


Figure 19 Ventilation duct plan – detail (shown turned 90 degrees)

2.13 Ventilation plan for the central unit / type / specific values

For the Hudson Passive Project, a Zehnder ComfoAir 200 heat recovery ventilator was installed with soundproofing and filters. The unit was installed inside the loft ceiling cavity central to the house and within the thermal envelope. Rigid steel ductwork was installed to transfer air to designated spaces within the home and to the exterior intake and exhaust ports on the East facade. Ducts between HRV and exterior insulated with 10.2cm fibrous insulation. Adequate ventilation flow to each room is essential to maintain comfort and healthy indoor air, and proper balance must be achieved to avoid creating pressure differentials across the building envelope. Therefore the ventilation system was commissioned and flows were measured and adjusted in each room to the design requirements.

Figure 20 HRV in second floor cavity

Figure 21 Supply air point in main room

Balancing of mass and air flow volume for fresh and exhaust air (maximum 10% misbalance):

Exhaust:	+68 cfm (measured without an exterior grille)
Inlet:	-72 cfm (measured without an exterior grille)
Imbalance:	5.9%
PHPP requirement:	65 cfm continuous

Figure 22 Commissioning results

2.14 Heat supply

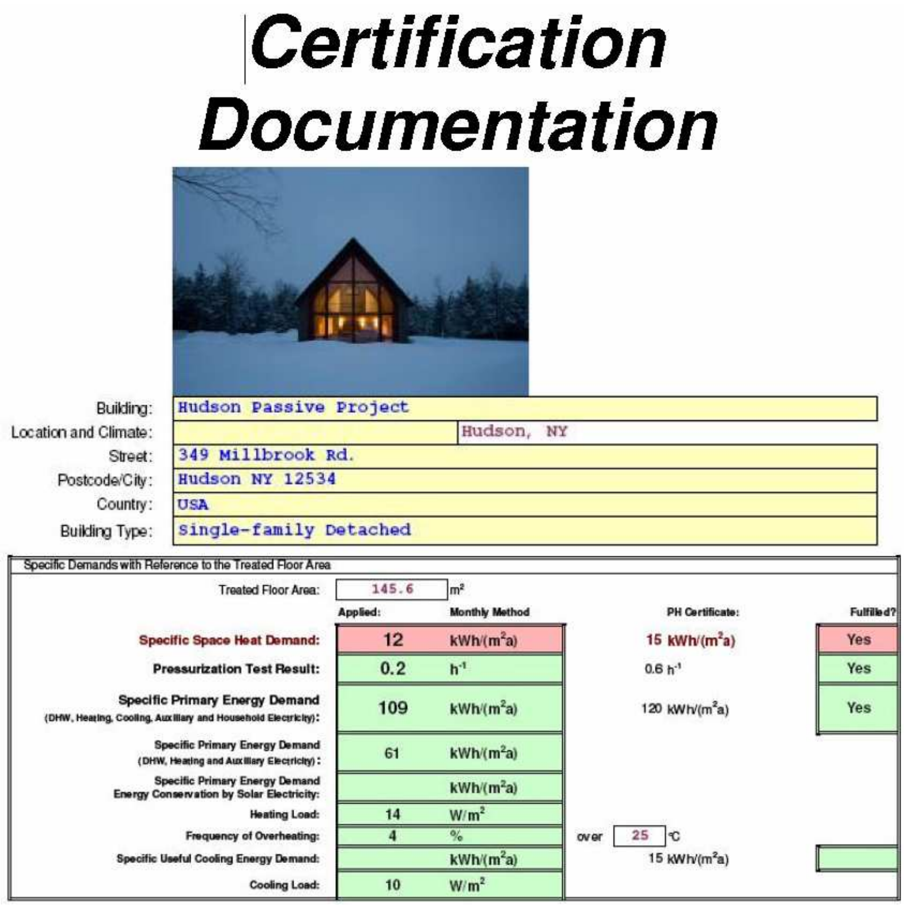
Our emphasis was putting resources into the structure of the building rather than bolt on renewable technologies that are subject to breakdown or for which superior technology may be available in future years. The space conditioning system can always be altered at a later date. Having no natural gas available and with LPG costly, we opted for a fully electric house. Given the propensity for cold winters and warm humid summers in the region, a mini-split heat pump with effective cooling at low outdoor temperatures was selected. This would also provide cooling when needed.

The heating need for home was calculated by PHPP as 14 W/m2 at the outside design temperature. The house has a floor area of 145.6 m2 so the total heat demand was calculated at 2,038.4 watts. The space heating at the Hudson Passive Project house comprised of the following:

- One mini-split heat pump in the main room: 12,507 Btu/hr (3. kW) heating capacity at 5°F (-15°C).
- One mini-split heat pump in the master bedroom: 10,900 Btu/hr (3.19 kW) heating capacity at 5°F (-15°C).
- A 500 watt backup electric resistance heater in the master bedroom

Figure 23 Heat pump indoor unit

2.15 Brief report on important PHPP results



Certification Documentation

Building:	Hudson Passive Project
Location and Climate:	Hudson, NY
Street:	349 Millbrook Rd.
Postcode/City:	Hudson NY 12534
Country:	USA
Building Type:	Single-family Detached

Specific Demands with Reference to the Treated Floor Area

Treated Floor Area: 145.6 m²

	Applied:	Monthly Method	PH Certificate:	Fulfilled?
Specific Space Heat Demand:	12	kWh/(m²a)	15 kWh/(m²a)	Yes
Pressurization Test Result:	0.2	h^{-1}	0.6 h^{-1}	Yes
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	109	kWh/(m²a)	120 kWh/(m²a)	Yes
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	61	kWh/(m²a)		
Specific Primary Energy Demand Energy Conservation by Solar Electricity:		kWh/(m²a)		
Heating Load:	14	W/m²		
Frequency of Overheating:	4	%	over 25 °C	
Specific Useful Cooling Energy Demand:		kWh/(m²a)	15 kWh/(m²a)	
Cooling Load:	10	W/m²		

Figure 24 Certification documentation verification page

2.16 -2.17 Costs

At an exchange rate of 0.7424 Euro (EUR) to 1 US Dollars (USD), costs of construction for the complete building (not including land or landscaping) were €464,000 (€3,787 per m^2 living space). Architectural and engineering services would add 18% to this cost.

2.18 Year of construction

2010-2011

2.19 Information on the architectural design

Architectural design by BarlisWedlick Architects, 85 Worth Street, 4th Floor, New York, NY 10013

2.20 Information on the building services planning

The building is served only by electric service. As discussed above, the building includes mini-split ductless heat pumps for primary heating and cooling. Domestic hot water is provided by a tankless electric water heater (Bosch AE125) located in mechanical closet under the stairs. All hot water taps are located in the central core so piping lengths are kept to a minimum.

2.21-2.22 Information on the structural physics and structural analysis planning, if applicable

The primary structure of the home is timber frame with glulam arches and beams supporting the SIP panels. Structural engineering of the SIP panel system was provided by the SIP supplier. General structural engineering for the home was provided by an independent structural engineering firm.

2.23 Experiences (user opinion, actual consumption values)

The house has now been occupied for over a year and feedback from occupants has been very positive. Following are comments collected from the owners after one year of residency:

- *"[The house is] unbelievably quiet. Even the dogs can't hear us coming up to the house when they are inside."*
- *"No drafts."*
- *"We did not have any overheating problems in the shoulder seasons or otherwise."*
- *"Temperature distribution in the house was pretty even; slightly warmer upstairs and in the bathrooms."*
- *"HRV was used 100% of the time. We used the setting adjustments from 1 (typical) to 3 (cooking) as needed. You can hear it slightly when on speed 3."*
- *"Indoor air quality was excellent."*
- *"[The heating system is] quiet, reacts fast and fulfills the heating need – only used it a few times over the entire winter."*

2.24 References to existing studies/publications on this project

A website devoted to the project may be found at http://hudsonpassiveproject.com/.